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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/802,150	03/17/2004	Keun-Hee Bai	8021-215 (SS-19582-US)	3946

22150 7590 04/24/2009

F. CHAU & ASSOCIATES, LLC
130 WOODBURY ROAD
WOODBURY, NY 11797

EXAMINER	
RAYMOND, BRITTANY L	

ART UNIT	PAPER NUMBER
1795	

MAIL DATE	DELIVERY MODE
04/24/2009	PAPER

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/802,150
Filing Date: March 17, 2004
Appellant(s): BAI ET AL.

Frank Chau

For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 10/01/2008 appealing from the Office action mailed 05/06/2008.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

2004/0192058	Chu et al.	09-2004
6830877	Ma et al.	12-2004
6326307	Lindley et al.	12-2001
4504574	Meyer et al.	03-1985
2003/0129816	Ko et al.	07-2003

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

2. Claims 1, 2, 5, 6, 9, 10, 12, 13, 15-17, 21 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chu (U.S. Patent Publication 2004/0192058) in view of Ma (U.S Patent 6830877).

Chu discloses a pattern forming method comprising: placing an etch stop layer on a substrate (Paragraph 0017), forming a dielectric insulating layer on the etch stop layer (Paragraph 0018), depositing an anti-reflective coating over the insulating layer (Paragraph 0020), placing a photoresist layer over the anti-reflective coating and carrying out a photolithographic process (Paragraph 0021), placing a second photoresist layer over the substrate, patterning the second photoresist layer (Paragraph 0023), exposing the patterned photoresist to a carbon monoxide containing plasma to form a polymer layer on the surface of the photoresist layer (Paragraph 0024), etching the substrate with fluorocarbon gas using the hardened photoresist layer as a mask (Paragraph 0028), and performing an oxygen ashing process to remove the photoresist layer (Paragraph 0029), as recited in claims 1, 2, 5, 6, 9, 10, 12, 13, 15-17, 21 and 23 of the present invention.

Chu fails to disclose that an ArF photoresist material is used.

Ma discloses a method for forming via and contact holes with a photoresist comprising imaging a photoresist material using an argon fluoride laser source since a 193 nm source is required (Column 2, Lines 7-11), as recited in claims 1, 9, 12, 15 and 21 of the present invention.

It would have been obvious to one of ordinary skill in the art, at the time of invention by applicant, to have used an ArF photoresist, as suggested by Ma, in the

process of Chu because Ma teaches that ArF light sources are a common type of deep ultraviolet light used in photolithography processes.

3. Claims 1, 2, 5-10, 12, 13, 15-17, 19-21, and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lindley (U.S. Patent 6326307) in view of Meyer (U.S. Patent 4504574) and Ma (U.S. Patent 6830877).

Lindley discloses an etching process comprising: providing a substrate with several metallization layers (Column 1, Lines 13-14), placing a photoresist layer on top of the oxide layer and patterning it to form a mask for etching (Column 4, Lines 62-64), pretreating the patterned photoresist layer and etching the metallization layers (Column 4, Lines 64-66), as recited in claims 1, 9, 12, 15 and 21 of the present invention. Lindley states that the etching is performed with a fluorocarbon plasma, as recited in claims 6, 9, 12 and 21 of the present invention. Since the layers are being exposed to fluorocarbon plasma during the etching process, this means that fluorine radicals are present during etching, as recited in claims 5 and 15 of the present invention. Lindley discloses that a dielectric layer, such as silicon dioxide, is typically used as one of the metallization layers being etched (Column 1, Line 15-16), as recited in claims 1 and 17 of the present invention. Lindley states that a polymer layer is formed over the top of the photoresist layer and the photoresist sidewalls during the fluorocarbon treatment (Column 3, Lines 55-56), as recited in claims 12 and 21 of the present invention. Lindley also states that carbon monoxide gas can be present during the plasma treatment (Column 8, Line 22), as recited in claims 2, 10, 13, 16 and 23 of the present invention. Finally, Lindley discloses that the main etch is performed in the same reactor

as the photoresist pretreatment, without extinguishing the plasma between the two steps (Column 5, Lines 49-51), as recited in claims 7 and 19 of the present invention. Lindley states that in this type of etch reactor, RF bias power is coupled to a pedestal electrode supporting the wafer to be etched (Column 5, Lines 8-10), which is taken to mean that power is supplied to the bottom of the wafer, as recited in claims 8 and 20 of the present invention. Lindley also states that the RF power increases when transitioning between photoresist pretreatment and the etching process (Column 5, Lines 53-55), as recited in claims 8 and 20 of the present invention. Lindley teaches that the photoresist is stripped by ashing after the etching process is complete (Column 4, Lines 55-57), as recited in claim 15 of the present invention. Lindley also teaches that a deep ultraviolet photoresist is used in the process (Column 2, Lines 22-26).

Lindley fails to disclose that plasma used for the photoresist treatment is formed using a fluorine-free carbon-containing gas, and that an ArF photoresist material is used.

Meyer discloses a pattern forming method comprising: placing a chromium layer onto a substrate, forming a photoresist layer on the chromium layer, exposing and developing the photoresist layer to form a pattern, exposing the photoresist layer to a carbon monoxide plasma to treat the surface of the photoresist layer, patterning the chromium layer by plasma etching, using the patterned photoresist layer as a mask, and removing the patterned photoresist layer (Column 2, Line 39-Column 3, Line 10). Meyer does not state that the carbon monoxide plasma contains fluorine, as recited in claims 1, 9, 12, 15 and 21 of the present invention.

Ma discloses a method for forming via and contact holes with a photoresist comprising imaging a photoresist material using an argon fluoride laser source since a 193 nm source is required (Column 2, Lines 7-11), as recited in claims 1, 9, 12, 15 and 21 of the present invention.

It would have been obvious to one of ordinary skill in this art, at the time of invention by applicant, to have used a fluorine-free carbon-containing gas, as suggested by Meyer, in the process of Lindley because Meyer teaches that this type of treatment enhances the resistance of a resist mask to an etching treatment. It also would have been obvious to one of ordinary skill in the art to have used an ArF photoresist, as suggested by Ma, in the process of Lindley because Ma teaches that ArF light sources are a common type of deep ultraviolet light used in photolithography processes.

4. Claims 3, 11, 14, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lindley (U.S. Patent 6326307) in view of Meyer (U.S. Patent 4504574) and Ma (U.S. Patent 6830877) as applied to claims 1, 2, 5-10, 12, 13, 15-17, 19-21, and 23 above, and further in view of Ko (U.S. Patent Publication 2003/0129816).

The teachings of Lindley, Meyer and Ma have been discussed in paragraph 3 above.

Lindley, Meyer and Ma fail to disclose that the plasma used in the treatment and etching processes can be generated by carbon dioxide.

Ko discloses a process for increasing silicon-containing photoresist selectivity comprising: providing a substrate with a photoresist placed on top, exposing the photoresist to a light source for patterning (Paragraph 0026), eventually curing the

photoresist layer with a plasma, which may be formed by carbon dioxide or carbon monoxide gas (Paragraph 0037), and etching the substrate in an etch chamber (Paragraph 0037).

It would have been obvious to one of ordinary skill in the art, at the time of invention by applicant, to have used carbon dioxide to generate a plasma, as suggested by Ko, in the process of Lindley, Meyer and Ma because Ko teaches that carbon dioxide works similarly to carbon monoxide to harden a layer of photoresist so that the photoresist layer is protected against etching.

(10) Response to Argument

1. Rejection of claims 1, 2, 5, 6, 9, 10, 12, 13, 15-17, 21 and 23 under 35 U.S.C. 103(a) as being unpatentable over Chu in view of Ma

a. *Claims 1, 9, 12, 15 and 21 are unpatentable over Chu in view of Ma because Chu discloses plasma generated by exciting a fluorine-free carbon-containing gas*

Appellants argue that Chu does not disclose plasma generated by exciting a fluorine-free carbon-containing gas. More specifically, Appellants argue that the carbon monoxide containing plasma of Chu may still include fluorine because carbon monoxide is often used with CH_2F_2 and C_4F_8.

The reference, Chu, teaches that a patterned photoresist layer is treated using a carbon monoxide containing plasma in order to remove photoresist residue along the opening in the photoresist and to form a polymer cross-linked surface portion of the photoresist layer to reduce an etching rate of the photoresist layer (Paragraph 0024). Chu states that the carbon monoxide containing plasma treatment process includes CO and a diluent gas, such as nitrogen, helium, argon or a combination thereof (Paragraph 0024). Chu does not mention that a fluorine is present during the plasma treatment. The only mention of a fluorine in Chu is in the discussion of the etching chemistry used to etch layers underlying the patterned photoresist layer (Paragraphs 0021 and 0028). Since Chu teaches that the carbon monoxide treatment is performed in order to reduce the etching rate of the photoresist, and that fluorine-containing chemistries are used for etching, it would be obvious to one of ordinary skill in the art that Chu would not want a fluorine present in the carbon monoxide treatment.

b. *Claims 1, 9, 12, 15 and 21 are unpatentable over Chu in view of Ma because Ma does not teach away from using an ArF photoresist material in connection with treating a photoresist pattern by exciting a carbon-containing gas as described in Chu*

Appellants argue that Ma teaches away from the treatment process of Chu because Ma discloses curing or annealing a photoresist layer prior to forming openings

in the photoresist layer, which is a different type of photoresist pretreatment than what is taught by Chu.

The reference, Ma, is simply combined with Chu to teach that ArF photoresists are often used in common photolithography processes. Also, Ma teaches that an ArF light source is a type of deep ultraviolet light (Column 2, Lines 7-11), which is used in the process of Chu. It would have been obvious to one of ordinary skill in the art to combine these references because each reference is teaching a process of patterning a DUV photoresist and each has a step of pretreatment so that a more accurate photoresist pattern is formed.

c. *Claims 1 and 17 are unpatentable over Chu in view of Ma because Chu discloses or suggests an etching target layer formed of a material selected from a group consisting of a silicon oxide layer, a silicon nitride layer, a silicon oxynitride layer, and an organic anti-reflective coating layer*

Appellants argue that Chu does not disclose an etching target layer than consists of a silicon oxide, silicon nitride, silicon oxynitride, or an organic anti-reflective coating layer. More specifically, Appellants argue that the silicon oxynitride layer of Chu is not an etching target layer, but rather is an etch stop layer.

Chu discloses forming a stack of layers on a substrate prior to patterning or etching these layers. The layers consist of a conductive region 23, an overlying etch

stop layer 24, a dielectric insulating layer 25, and an anti-reflective coating 26 (Paragraphs 0017-0020 and Figure 2A). After patterning the layers a first time, a photoresist layer is formed over the structure, is patterned to form 32B, is treated with the carbon monoxide to form 32C, and is then used as a mask to etch the underlying layers (Figures 2C-2E). It is apparent from Figure 2F, which is the final structure formed, that the treated photoresist is used to etch two layers, the anti-reflective coating 26 and the dielectric insulating layer 25. Therefore, both the anti-reflective coating and the dielectric insulating layer could be considered as etching target layers. Since Chu teaches that the anti-reflective coating can be silicon oxynitride (Paragraph 0020), this would lead to an etching target layer which consists of silicon oxynitride.

2. Rejection of claims 1, 2, 5-10, 12, 13, 15-17, 19-21 and 23 under 35 USC 103(a) as being unpatentable over Lindley in view of Meyer and Ma

a. *Claims 1, 9, 12, 15 and 21 are unpatentable over Lindley in view of Meyer and Ma because Meyer discloses that the carbon monoxide plasma is a fluorine-free carbon-containing gas*

Appellants argue that Meyer does not disclose plasma generated by exciting a fluorine-free carbon-containing gas.

Meyer teaches that a patterned photoresist layer is treated using a carbon monoxide containing plasma in order to enhance resistance of the resist mask to

plasma etching (Column 2, Lines 4-7). Meyer does not mention that a fluorine is present during the plasma treatment. Meyer only states that the patterned photoresist layer is treated with a carbon monoxide plasma (Column 2, Lines 54-56). Since fluorine is not discussed in Meyer, it would be assumed it is not present in the carbon monoxide plasma treatment.

Appellants also argue that one of ordinary skill in the art would not modify a fluorine contained plasma of Lindley to include a fluorine free plasma of Meyer because Lindley teaches that the fluorine containing plasma is crucial for the pretreatment of the photoresist layer.

Meyer teaches that the carbon monoxide plasma treatment enhances the resistance of the resist mask to an etching treatment, which is also desired in the process of Lindley. Although Lindley uses certain fluorine containing gases in the pretreatment, it is made clear that fluorine-based etchants are avoided for this step Column 5, Lines 44-48). Also, Lindley teaches that carbon monoxide used in the pretreatment chemistry scavenges fluorine so that the polymer formed is carbon rich, similar to the photoresist (Column 8, Lines 65-67). It is apparent that Lindley is suggesting that while fluorine containing plasmas may help to form protective materials on a photoresist layer, carbon materials are more desired for treating a photoresist layer. Therefore, the pretreatment plasma of Meyer would have a more desired outcome because it only contains carbon and does not have a fluorine, which may start to etch through the photoresist sidewalls.

b. *Claims 1, 9, 12, 15 and 21 are unpatentable over Lindley in view of Meyer and Ma because Ma does not teach away from using an ArF photoresist material in connection with treating a photoresist pattern by plasma as described in Lindley*

Appellants argue that Ma teaches away from the treatment process of Lindley because Ma discloses curing or annealing a photoresist layer prior to forming openings in the photoresist layer, which is a different type of photoresist pretreatment than what is taught by Lindley.

The reference, Ma, is simply combined with Lindley to teach that ArF photoresists are often used in common photolithography processes. Also, Ma teaches that an ArF light source is a type of deep ultraviolet light (Column 2, Lines 7-11), which is used in the process of Lindley. It would have been obvious to one of ordinary skill in the art to combine these references because each reference is teaching a process of patterning a DUV photoresist and each has a step of pretreatment so that a more accurate photoresist pattern is formed.

3. Rejection of claims 3, 11, 14 and 24 under 35 USC 103(a) as being unpatentable over Lindley in view of Meyer and Ma and further in view of Ko

a. *Claims 3, 11, 14 and 24 are unpatentable over Lindley in view of Meyer and Ma and further in view of Ko because these dependent claims depend from claims 1, 9, 12 and 21, respectively, and their limitations are disclosed by the cited art*

Appellants argue that claims 3, 11, 14 and 24 are patentable over Lindley in view of Meyer and Ma and further in view of Ko because they depend from claims 1, 9, 12 and 21 respectively.

Claims 1, 9, 12 and 21 are considered to be unpatentable over Lindley in view of Meyer and Ma. Also, Ko teaches that a photoresist layer can be treated with a carbon dioxide containing gas to form a hardening layer on the photoresist (Paragraph 0037). Therefore, claims 3, 11, 14 and 24 are unpatentable over Lindley in view of Meyer and Ma and further in view of Ko.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/Brittany Raymond/

Examiner, Art Unit 1795

Conferees:

/Mark F. Huff/

Supervisory Patent Examiner, Art Unit 1795

/Jennifer Michener/

QAS, TC1700